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# GUIDELINES FOR LOG GRADING COAST DOUGLAS-FIR

PACIFIC NORTHWEST  
FOREST AND RANGE EXPERIMENT STATION  
U.S. DEPARTMENT OF AGRICULTURE  
FOREST SERVICE      PORTLAND, OREGON

#### METRIC CONVERSIONS

1 inch = 2.54 centimeters

1 foot = 0.3048 meter

1 meter = 39.370 inches

1 meter = 3.2808 feet

Diameter at breast height (d.b.h.)

= 4.5 feet = 54 inches = 1.37 meters

Nominal 16-foot log = 4.88 meters

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# ***Guidelines for Log Grading Coast Douglas-fir***

## *Reference Abstract*

Lane, Paul H., and Richard O. Woodfin, Jr.

1977. Guidelines for log grading Coast Douglas-fir. USDA For. Serv. Res. Pap. PNW-218, 14 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This report is a photographic guide to the application of the new four-grade system for cruising Coast Douglas-fir. It is intended as both a training aid and illustration of features that lower grades.

KEYWORDS: Grading (log), timber cruising, defect indicators (wood quality), Coast Douglas-fir, *Pseudotsuga menziesii*, old-growth stands.

## **RESEARCH SUMMARY**

*Research Paper PNW-218*

1977

This report presents guidelines for applying the four-grade system of timber cruising grades for Coast Douglas-fir. It is intended for use by timber cruisers and grading instructors to insure uniform application of the new grades. Photographs

are used to define and describe log characteristics that are grading defects.

A summary of log grade specifications is included.



This publication, a supplement to "New Timber Cruising Grades for Coast Douglas-fir,"<sup>1/</sup> provides auxiliary information about log defects and the grading specifications described in the earlier paper. It is intended primarily to assist timber cruisers in grading coast-type, old-growth Douglas-fir.

## **General Rules for Applying the Grades**

1. The grades are applied to live, standing, old-growth, coast-type Douglas-fir. "Old growth" is defined as timber estimated to be more than 100 years old. "Coast-type" is the botanical variety of Douglas-fir *Pseudotsuga menziesii* (Mirb.) Franco variety *menziesii*, growing west of the crest of the Cascade Range in Washington and Oregon and the Sierra Nevada Mountains of northern California.

The grades are applicable to recently dead or blown down timber if, in the judgment of the cruiser, such timber has not deteriorated significantly--i.e., the expected yield of lumber or veneer would not be different from the same timber in a live and standing condition.

2. When the grades are applied, the tree stem is considered to be divided into nominal 16-foot (4.88 meters) consecutive segments or logs. The term "log" as used in this paper refers to the designated and uncut 16-foot section of a standing tree. If the cruising procedure specifies the in-

clusion of a trim allowance in the nominal 16-foot log length, the grading specifications must be applied to the entire length.

3. Each log is designated either "merchantable" or "nonmerchantable." Logs at least one-third sound are considered merchantable. Logs having a cruise volume deduction of more than two-thirds of their gross volume are designated "nonmerchantable" or "cull."
4. Each merchantable log is graded separately and without regard for the condition or grade of adjoining logs, *except when adjacent to a cull*. Logs meeting the specifications for Grades I, II, or III must be lowered one grade when they are adjacent to a cull log.
5. The grading specifications are applied to each log by "log faces." A log face is one-fourth the log circumference for the full length of the log.

Log faces are established by the cruiser according to the presence (or absence) of log characteristics affecting the log grade. The objective is to select the best face (most knot-free) or the poorest (face with the largest percent of surface area covered by knots).

Once the grading faces of a log are established, they cannot be shifted *except* for large burls (this exception is explained under item "7" in the following section on grading specifications).

6. The grading specifications are applied to each merchantable log, usually starting with the butt log and progressing up the tree stem.

A tentative grade of each log is determined by applying the knot (or knot indicator) specifications--then the other grading criteria for such defects as scars, conks, or

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<sup>1/</sup> Lane, Paul H., Richard O. Woodfin, Jr., John W. Henley, and Marlin E. Plank. 1973. New timber cruising grades for Coast Douglas-fir. USDA For. Serv. Res. Pap. PNW-151, 12 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.



bumps are applied to establish the final grade. For example, if the log segment is knot free, it is a potential Grade I; the grader would then look for other possible limiting defects to establish the final grade.

The grading specifications to be applied by the above general rules and summarized in table 1 are described in more detail in the following section.

## Description of the Log Grading Specifications

1. *Sound knots* are live or dead limbs or limb stubs on a log that show no evidence of decay. They are important defects in grading as their presence means knots in the underlying wood (usually continuing to the pith of the log). Consequently, they lower value of logs for producing lumber, veneer, or other products. The number, size, and location of knots are important criteria in determining log grade (table 1).

Knot size (diameter) is measured at the log surface, *inside* any limb bark that may be present, *but excluding* the limb collar or any swelling present at the surface juncture (fig. 1).

Limbs causing knots may be live or dead and may protrude from the log surface (fig. 2) or be broken off, leaving a stub flush with the surface or an open depression (fig. 3). The only exception to these definitions of sound knots is for small epicormic branches described later in item 10.

2. *Rotten knots* are live or dead limbs or limb stubs that show evidence of decay or rot. They often appear as black bumps and may exude discolored pitch (fig. 4). Rotten knots indicate serious

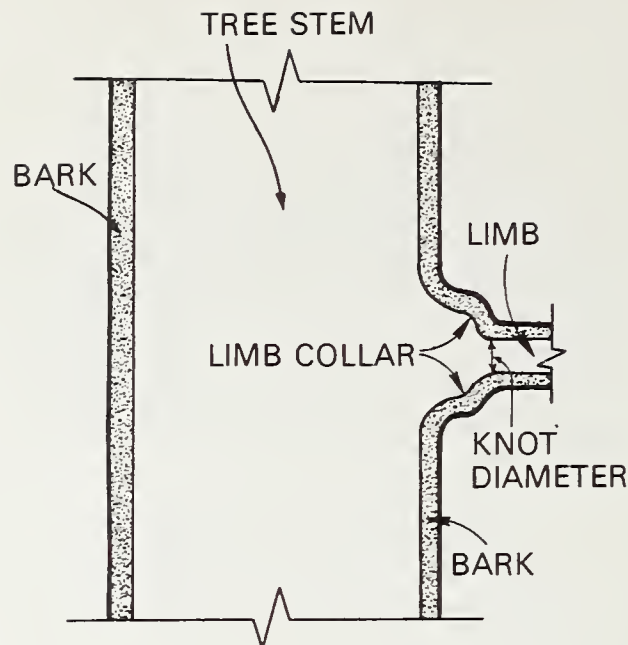


Figure 1.--Schematic drawing of a cross section of a log and limb showing how knot size is determined from measurements (or estimates) of limb diameter inside any limb bark present. Excludes the limb collar or common swelling at juncture with the log surface.



Figure 2.--Numerous dead limbs and stubs (knots) on a Grade IV butt log. This log does not qualify for Grade II for two reasons: (1) it does not have two clear (knot-free) faces, and (2) some of the knots are larger than 2 inches in diameter and cannot be confined to the upper or lower half of one face. The log does not qualify for Grade III because the knots that are larger than 3 inches cannot be confined to one face.



Table 1—A summary of cruising grades for Coast Douglas-fir

Log characteristic	Grade I <sup>1/</sup>	Grade II <sup>1/</sup>	Grade III <sup>1/</sup>	Grade IV
Knot (sound)	One allowed if 1 inch or less or one larger than 1 inch if within 6 inches of log end.	None allowed on two faces. Knots larger than 2 inches must be confined to upper or lower half of one face.	Knots (sound or rotten) larger than 3 inches must be confined to one face.	Any merchantable log not meeting requirements for Grade III.
Rotten knot	None allowed.	None allowed unless log is otherwise Grade I.		
Knot indicator	If larger than 1 inch, must be confined to no more than two faces.	No requirements.		
Knot cluster	None allowed.	One if confined to one face.	Any number if confined to no more than two faces.	
Indicator cluster	One allowed if confined to one face.	No requirements.		
Degrading scar	None allowed from ground line to 8 feet. Above 8 feet: No limit for <u>sound</u> scars 6 inches x 6 inches or smaller; larger <u>sound</u> scars must be confined to either one face or not more than two faces in any one-fourth of log length. No rotten scars allowed.	All scars having rot must be confined to one face.	No requirements.	
Sound burl <sup>2/</sup>	Disregard burls if less than 6 inches in diameter.			
	If larger than 6-inch diameter, must be confined to one face.	All larger than 6-inch diameter must be confined to three faces.		
Conk, canker, and unsound burl	None allowed.	No requirements if log is otherwise Grade I.	No requirements	
Bump and bulge	None 6 inches x 6 inches or larger allowed from ground line to 8 feet. No requirements above 8 feet.	No requirements.		
Epicormic branches and holes	Must be confined to one face.			

<sup>1/</sup> A log meeting specifications for either Grade I, II, or III is lowered one grade if adjacent to a cull log.

<sup>2/</sup> When burls are considered, log faces can be shifted from the faces initially established for knots or other characteristics.



Figure 3.--Knot from dead limb broken off just below log surface, leaving a shallow depression. This is a 1-3/4-inch knot and therefore is not allowed in a Grade I log unless it is the *only* knot larger than 1 inch on the log *and also* is located within 6 inches of the log's end. Any number of sound knots less than 2 inches in diameter are allowed on Grade II logs *providing* the log has two clear (knot-free) faces.



Figure 4.--Typical rotten knots: A, Knot with decay evident on and around the limb stub. This type of knot is permitted on a Grade II log if it is the *only* knot (live or dead) on the log *and, in addition*, is within 6 inches of the log end (as it is larger than 1 inch). B, Numerous decaying knots on a Grade IV butt log; knots are exuding black pitch. This log does not qualify for Grade III because there are knots (sound or rotten) larger than 3 inches that cannot be confined to one face.



deterioration in the underlying wood and therefore are not allowed in Grade I logs. They are only permitted in Grade II logs that are otherwise of Grade I quality. In Grade III logs, rotten knots larger than 3 inches in diameter must be confined to one face (table 1).

3. *Knot indicators* are bark distortions that indicate the presence of underlying knots. As knots become overgrown and buried by tree growth, concentric rings or linear breaks in the normal bark pattern may persist for many years. The early stages of the overgrowth may be covered with callous tissue.

Many indicators are circular or elliptical with a small depression or hole in the center.

The size of knot indicators is an important grading criterion. Indicators of less than 1 inch in diameter generally mean the underlying knot is so deeply buried that wood product yield will not be significantly affected. Therefore, only knot indicators larger than 1 inch in diameter are considered in grading. Figure 5 illustrates how indicator size is measured. Some examples of typical knot indicators are shown in figures 6 through 8.

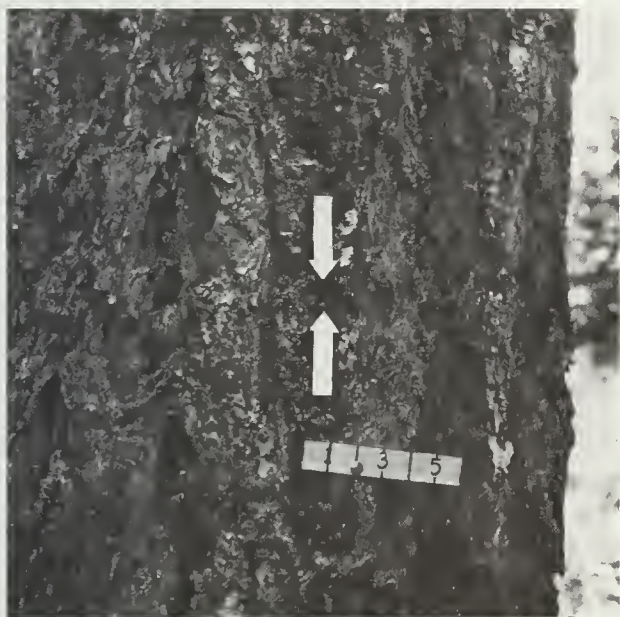


Figure 5.--An elliptical knot indicator. Size is determined by the vertical distance across the depression as shown by the arrows. This indicator is slightly larger than 1 inch. All such indicators must be confined to one face on Grade I logs. Indicators, regardless of size or number, are not degrading for Grades II, III, or IV.

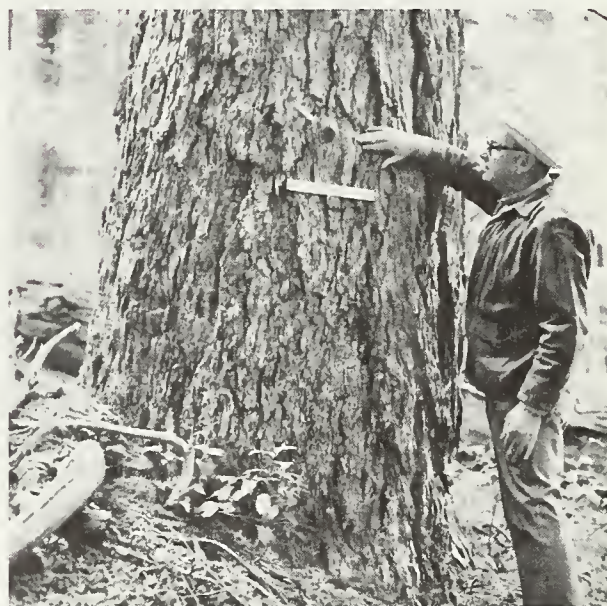


Figure 6.--This 2-inch indicator would be allowed in a Grade I log provided it and any others larger than 1 inch were confined to no more than two faces.





Figure 7.--A horizontal break in the bark caused by a former limb that is now a knot indicator. Size is measured vertically (between arrows).

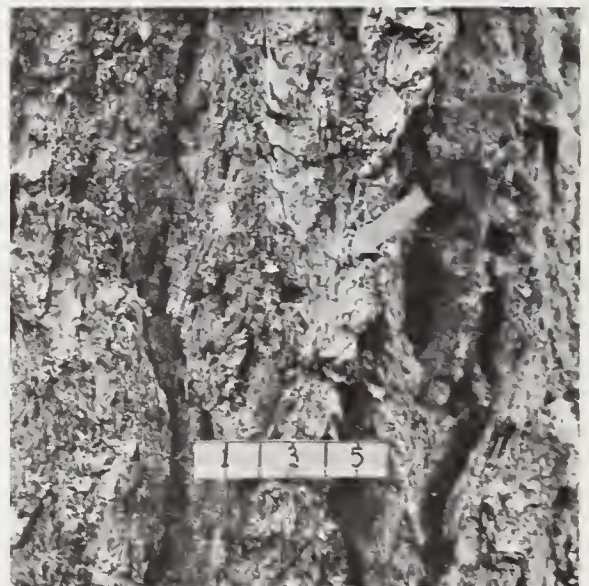


Figure 8.--Typical small indicators less than 1 inch in size. These would be ignored in grading.



4. *Knot clusters* are three or more sound limbs or stubs, all of which are 1 inch or larger, that form a contiguous group (fig. 9). They signify a relatively large and serious defect in the underlying wood. They are not allowed in Grade I logs. One is permitted in a Grade II log if it is confined to one face. In Grade III logs, any number of clusters are allowed *provided* they are confined to no more than two faces.

5. *Indicator clusters* are three or more contiguous knot indicators. They usually form a distinct bark pattern rising above the log surface (fig. 10). One is allowed on a Grade I log if it can be confined to one face. They are not considered defects in Grades II, III, or IV.



Figure 9.--A typical knot cluster with three or more limbs or stubs of 1 inch or larger. Knot clusters are not allowed in Grade I logs. This knot cluster extends into two log faces and therefore would not be allowed in a Grade II log. Any number of clusters are allowed in a Grade III log if confined to no more than two faces.



Figure 10.--A typical indicator cluster. This cluster of indicators is confined to one log face and therefore would be allowed on a Grade I log providing it was the only one on the log. Any number of any size of indicator clusters are permitted in Grades II, III, and IV.

6. *Scars* are the result of injury to the tree stem from such things as fire, logging, frost, lightning, and falling limbs or trees. Scars from recent injuries may show only exposed wood; older wounds may have callous tissue around the edges or be completely overgrown. Overgrown scars often have underlying rot. Pitch is often present in scars. Exposed wood may have checks from weathering and may be stained or show signs of decay. Scars with advanced rot may have a hole or hollow area where the underlying wood has disappeared. Various types of scars are illustrated in figures 11 through 15.

The size, location, and soundness of scars are particularly important for Grade I specifications. In Grade I butt logs no scars are allowed from the ground line to 8 feet up the stem except that an open and shallow scar of recent origin may be considered superficial





Figure 11.--A sound, partially overgrown scar. This would not be allowed in a Grade I log but would be permitted in Grade II even if it had signs of decay because it is confined to one face.



Figure 12.--An overgrown scar that should be assumed to have underlying rot. It would be permitted in a Grade II log as it is confined to one face.

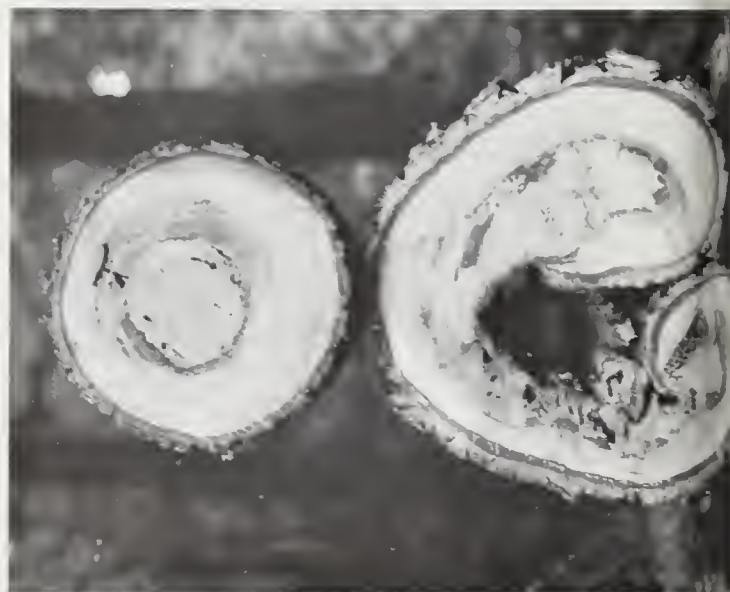


Figure 13.--A, Butt log with partially overgrown scar and void caused by advanced decay; B, cross sections of the same butt log at 3 feet and 10 feet above ground showing interior cavity and decayed wood.





Figure 14.--A long, partially overgrown seam probably caused by lightning. This scar extends in a spiral pattern along the tree stem and cannot be confined to one face. It would not be allowed in a Grade II log.

and be disregarded if, in the judgment of the cruiser, lumber or veneer recovery will not be affected (fig. 16). On sloping ground this 8-foot distance is measured from the uppermost point on the slope (fig. 17). Above 8 feet, any number of sound, small (6 by 6 inches or less) scars are permitted--larger *sound* scars must be confined to either one face or not more than two faces in any one-fourth of the log's length. No scars with decay, regardless of size or location, are permitted in Grade I logs.

For Grade II the only requirement is that scars having decay must be confined to one face. There are no scar criteria for Grades III or IV.

7. *Sound burls* are round or elliptical woody growths that protrude abruptly from the log surface and have no evidence of decay or exuding pitch (figs. 18 and 19). They usually have a broken



Figure 15.--A sound scar, about 8 by 10 inches, near the upper end of the butt log. This type of scar is permitted in Grade I logs if it is confined to one face. If the scar (open and sound) extended into two faces, it would also be allowed in Grade I logs *providing* it was limited to any one-fourth of the log's length and, if on a butt log, was 8 feet above ground line. Any number of sound scars above 8 feet are permitted in Grade I logs *providing* they are 6 by 6 inches or smaller.

bark pattern characterized by small, knobby or irregular patches of bark. Their point of attachment is characteristically smaller in diameter than the maximum





Figure 16.--A recent logging scar that would not affect product recovery, particularly since most of it is in the stump area. This scar would be considered superficial and would be disregarded in grading.

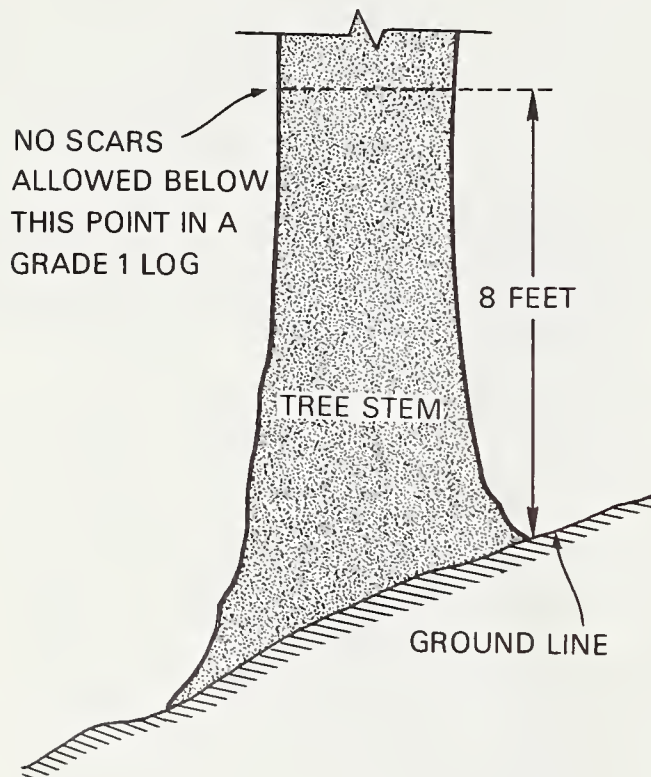


Figure 17.--Schematic drawing of lower section of butt log showing how the limiting 8-foot distance from ground line is measured on trees on a slope. Note that this limiting 8-foot distance extends below the lower end of the butt log to include all of the estimated stump area.



Figure 18.--A sound burl larger than 6 inches that would be permitted in Grade I logs because it is confined to one face.

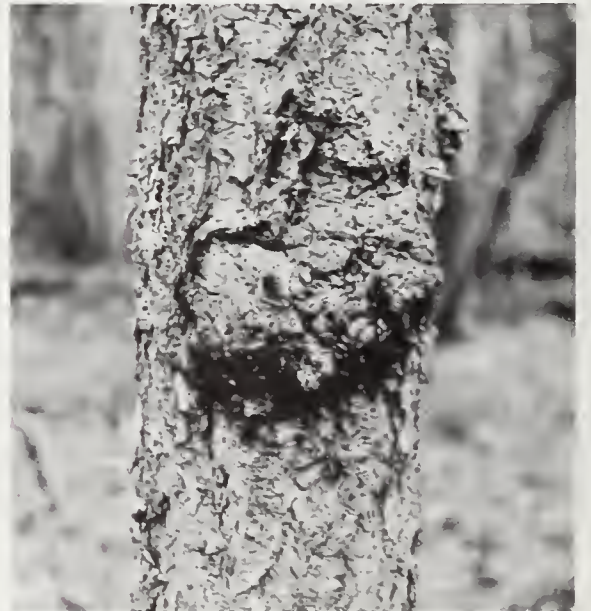


Figure 19.--A sound burl that would not be permitted in Grade I logs because it is not confined to one face. It would be allowed in Grade II logs because it can be confined to three faces.



diameter of the burl as it extends from the trunk. These characteristics distinguish burls from cankers described in the following section (item 8).

Small, sound burls (less than 6 inches in diameter) are not degrading and should be disregarded. Larger burls generally cause distorted grain in the underlying wood, and therefore, the area they cover is limited for grading. Burls larger than 6 inches in diameter must be confined to one face for Grade I logs. For Grades II and III, all burls larger than 6 inches must be confined to not more than three faces.

Log grading faces can be shifted so that burls are grouped as much as possible. Such shifting of faces is independent of the

principal grading faces established on the basis of knots or indicators.

8. *Conks, cankers, and unsound burls* indicate the presence of decay in the interior of a log. These characteristics are not allowed in Grade I logs and are only permitted in Grade II logs that otherwise meet the specifications for Grade I.

Conks are the fruiting bodies of wood-rotting fungi. On the trunks of mature Douglas-fir, the most common conks are caused by *Phellinus pini* (Thore ex Fr.) Pilát (= *Fomes pini*) (fig. 20). Conks of a red brown butt rot are caused by *Phaeolus schweinitzii* (Fr.) Pat. (= *Polyporus schweinitzii*), commonly called velvet top fungi; they may also be found on the roots (fig. 21) or on the lower portion of the butt log but rarely are they found above



Figure 20.--Conks of *Phellinus pini* (Thore ex Fr.) Pilát (= *Fomes*).  
This is the most common trunk rot of Douglas-fir.





Figure 21.--A typical *Phaeolus schweinitzii* (Fr.) Pat. (=Polyporus *schweinitzii*), or "velvet top" conk on the tree root collar. Although it is below the butt log, it is evidence of serious red brown cubical rot extending into the butt log and therefore precludes the log from being Grade I. This butt log would also not qualify for Grade II unless it was otherwise of Grade I quality.

the first 16 feet of the trunk.<sup>2/</sup> *Phaeolus schweinitzii* conks found below the butt log or the stump or on the roots *should be considered as occurring on the butt log*; such a log could not qualify for Grade I and could only be Grade II if it is otherwise of Grade I quality. These specifications for conks do not prevent a cruiser from "culling" a log if, in his judgment, the number and location of conks warrant it.

Cankers are lesions in the bark characterized by swelling and convolutions of callous tissue and pitch.

<sup>2/</sup> Boyce, John Shaw. 1961. Forest Pathology, the American Forestry Series. McGraw-Hill Book Co., New York, Toronto, London.

They have sloping edges and a maximum diameter occurring at the base where they protrude from the trunk (fig. 22). They are usually caused by dwarf mistletoe and rusts.



Figure 22.--Typical cankers. Like conks, they are not permitted on Grade I logs and are permitted only on Grade II logs that otherwise meet the specifications for Grade I. They are permitted in Grades III and IV logs.



Unsound burls showing evidence of decay and pitch (fig. 23) are rare on Douglas-fir; when present, they should be considered the same as conks or rotten knots, i.e., they are not allowed on Grade I logs and are allowed only on Grade II logs that are otherwise of Grade I quality. Rotten knots that are swollen and overgrown with knobby bark sometimes have the appearance of unsound burls.



Figure 23.--Unsound burls. They indicate decay in the underlying wood and, like conks and cankers, are not permitted on a Grade I log and are only permitted on a Grade II log that is otherwise of Grade I quality. The grading faces may not be shifted to accommodate unsound burls as they may be for sound burls.

9. *Bumps and bulges* are bark-covered swellings that do not conform to the normal taper in the tree stem or the normal swelling in butt logs (fig. 24). They may occur at any point on the tree stem but are only considered degrading in the butt log. They often indicate decay in the interior of the log. In Grade I logs, no bumps or bulges larger in area than 6 by 6 inches are allowed from ground line to 8 feet up the stem. On sloping ground the 8-foot distance

is measured from the uphill side (see fig. 17). Above 8 feet from ground line, all bumps and bulges can be disregarded in grading. These grading rules do not prevent the cruiser from making a log *volume* deduction for a bump or bulge.



Figure 24.--These bumps and bulges are in the lower 8 feet of the tree and therefore are not allowed in Grade I logs. Only bumps or bulges smaller than 6 by 6 inches in area are allowed in this 8-foot section for Grade I logs. There are no bump or bulge requirements for Grades II, III, or IV.



10. *Epicormic branches* are small (less than one-half inch), sprout-type limbs that originate from latent or dormant buds just under the bark. Underlying the epicormic branch or stub is a correspondingly small knot that generally does not extend very far into the wood. The only grading requirement is that they be confined to one face for Grade I logs.

11. *Holes* are defined as the small openings in the bark caused by bird pecking or insect activity (fig. 25). Such activity usually results in stained spots with embedded bark in the underlying wood. Bird pecking is often repeated year after year on the same tree, resulting in layers of overgrown peck spots. Holes are considered degrading only for Grade I logs where they must be confined to one face.

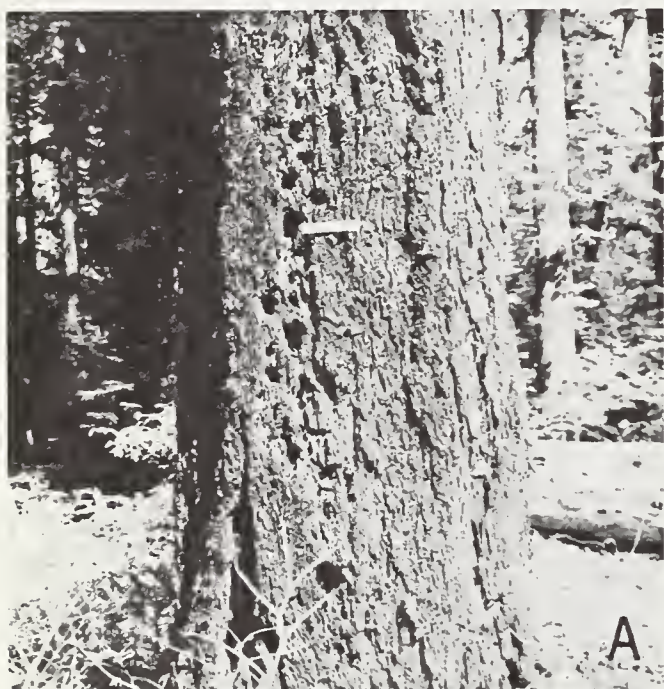


Figure 25.--A, Holes in the bark caused by combined bird and insect activity; B, Typical bird peck holes. In both illustrations, the holes are confined to one log face and, therefore, are permissible in Grade I logs.



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